

10/534770

JC06 Rec'd PCT/PTO 13 MAY 2005

**Translation of**

**AMENDMENT UNDER ARTICLE 19(35 U.S.C. 371(c)(3))**

**PCT/JP2004/006767**

## CLAIMS

1. (amended) An optical module being an optical transmitter module or optical transmitter and receiver module internally comprising:

a measurement portion for measuring a laser diode temperature and bias current or only the temperature;

a storage portion in which the relationship between the temperature, bias current and wavelengths or between the temperature and wavelengths is stored; and

a central controlling portion for controlling the measurement portion and the storage portion; wherein

a wavelength of the laser diode is monitored by calculating the wavelength on the basis of the relationship stored in the storage portion.

2. The optical module according to Claim 1 comprising a laser diode drive current controlling circuit provided therein, which controls the drive current of the laser diode, and includes a feature of feeding the bias current information calculated from the measurement portion back to the laser diode drive current controlling circuit.

3. The optical module according to Claim 1 or 2 comprising a temperature adjusting portion composed of a temperature controlling device provided therein and includes a feature of feeding the wavelength information

calculated from the storage portion back to the temperature adjusting portion.

4. (amended) A method for monitoring wavelengths in  
5 an optical transmitter module or optical transmitter and receiver module internally including a measurement portion for measuring a laser diode temperature and bias current or only the temperature, a storage portion in which the relationship between the temperature, bias current and  
10 wavelengths or between the temperature and wavelengths and threshold values related to wavelengths are stored, and a central controlling portion for controlling the measurement portion and the storage portion, wherein the method comprising a steps of:

15 calculating wavelength information on the basis of the relationship between the temperature and bias current measured by the measurement portion or the temperature and the laser diode temperature and wavelength stored in the storage portion, or between the laser diode temperature,  
20 bias current and wavelengths; and

comparing the wavelength information with the threshold values to the wavelength.

5. The method for monitoring wavelengths according  
25 to Claim 4, wherein

the step for calculating wavelength information obtains  $\lambda_c$ ,  $i_c$ ,  $a$ , and  $b$  in Equation (1) or  $\lambda_c$  and  $a$  in

Equation (2) by using the temperature and bias current or the temperature measured by the measurement portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion, and calculates wavelength information;

$$\lambda = \lambda_c + aT + b(i - i_c) \quad \dots \dots \text{Equation (1)}$$

(where  $\lambda_c$  is a wavelength at temperature 0°C and  
 10 threshold current value  $i_c$ , a and b are coefficients, T  
 is a temperature, and i is a bias current).

6. The method for monitoring wavelengths according to Claim 4, wherein

15           the step of calculating wavelength information  
selects a smaller temperature value T1 than the measured  
temperature Tmes, a larger temperature value T2 than the  
measured temperature Tmes, a smaller bias current value  
I1 than the measured bias current Imes and a larger bias  
current value I2 than the bias current value Imes by using  
20          the temperature and bias current measured by the measurement  
portion, and the relationship between the laser diode  
temperature, bias current and wavelengths stored in the  
storage portion; extracts four wavelengths ( $\lambda_{11} = \lambda(I_1,$   
 $T_1)$ ,  $\lambda_{21} = \lambda(I_2, T_1)$ ,  $\lambda_{12} = \lambda(I_1, T_2)$ , and  $\lambda_{22} = \lambda(I_2, T_2)$ )  
25          corresponding thereto; and calculates the wavelength  $\lambda_{mes1}$   
               $= \lambda(I_{mes}, T_1)$  at the measured bias current Imes by linearly

interpolating the bias current dependency of the wavelengths at temperature T1 using  $\lambda_{11}$  and  $\lambda_{21}$ ; calculates the wavelength  $\lambda_{mes2} = (\text{Imes}, \text{T2})$  at the measured bias current Imes by linearly interpolating the bias current dependency of the wavelength at temperature T2 using  $\lambda_{12}$  and  $\lambda_{22}$ ; and calculates the wavelength  $\lambda_{mes} = (\text{Imes}, \text{Tmes})$  at the measured bias current Imes and temperature Tmes by linearly interpolating the temperature dependency of the wavelength at the bias current Imes using the calculated  $\lambda_{mes1}$  and  $\lambda_{mes2}$ .

7. The method for monitoring wavelengths according to Claim 4, wherein

the step of calculating wavelength information selects a smaller temperature T1 than the measured temperature Tmes, a larger temperature T2 than the measured temperature Tmes, a smaller bias current I1 than the measured bias current Imes, a larger bias current I2 than the measured bias current Imes, and a bias current I3 differing from the bias currents I1 and I2 by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts six wavelengths ( $\lambda_{11} = \lambda(I1, T1)$ ,  $\lambda_{21} = \lambda(I2, T1)$ ,  $\lambda_{12} = \lambda(I1, T2)$ ,  $\lambda_{22} = \lambda(I2, T2)$ ,  $\lambda_{31} = \lambda(I3, T1)$ , and  $\lambda_{32} = \lambda(I3, T2)$ ) corresponding thereto; approximates the bias current dependency of the wavelength at the temperature

T1 by a quadratic function using  $\lambda_{11}$ ,  $\lambda_{21}$  and  $\lambda_{31}$ ; approximates the bias current dependency of the wavelength at the temperature T2 by a quadratic function using  $\lambda_{12}$ ,  $\lambda_{22}$  and  $\lambda_{32}$ ; and calculates the wavelength  $\lambda_{mes} = \lambda(I_{mes}, T_{mes})$  at the measured bias current  $I_{mes}$  and temperature  $T_{mes}$ .

8. The method for monitoring wavelengths according to Claim 4, wherein

the step of calculating wavelength information extracts a wavelength information by causing the measured temperature and bias current to correspond to any one of the temperatures or the temperature and bias current stored in matrices indicating the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelength stored in the storage portion.

9. A method for monitoring and controlling wavelengths of an optical transmitter module or optical transmitter and receiver module internally including: a measurement portion for measuring a laser diode temperature and bias current or only the temperature; a storage portion in which the relationship between the temperature, bias current and wavelengths or between the temperature and wavelengths is stored; a central controlling portion for controlling the measurement portion and the storage

portion; and a temperature adjusting portion composed of a temperature controlling device, wherein the method comprising steps of:

calculating wavelength information on the basis of  
5 the temperature and bias current or only the temperature measured by the measurement portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion; and

10 adjusting and controlling the internal temperature by feeding back to the temperature adjusting portion using the calculated wavelength information.

10. (amended) The method for monitoring and  
15 controlling wavelengths according to Claim 9, further comprising a step of:

comparing the threshold values, in which the minimum value and maximum value of wavelengths are predetermined, with the wavelength information calculated in the step of  
20 calculating wavelength information; wherein

the step for controlling temperature feeds back to the temperature adjusting portion when the result of comparison made by the wavelength information comparing step is outside the threshold values, lowering the internal  
25 temperature by the temperature adjusting portion when the result is smaller than or equal to the minimum value of the threshold values, and raising the internal temperature

by the temperature adjusting portion when the result is larger than or equal to the maximum value of the threshold values.

5        11. The method for monitoring and controlling wavelengths according to Claim 10, wherein,

the step of calculating wavelength information uses the temperature and bias current or only the temperature measured by the measuring portion, and the relationship 10 between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion, and calculates wavelength information by obtaining  $\lambda_c$ ,  $i_c$ ,  $a$ , and  $b$  in Equation (1) or  $\lambda_c$  and  $a$  in Equation (2);

15         $\lambda = \lambda_c + aT + b(i - i_c)$  .....Equation (1)

$\lambda = \lambda_c + aT$  .....Equation (2)

(where  $\lambda_c$  is a wavelength at temperature 0°C and threshold current value  $i_c$ ,  $a$  and  $b$  are coefficients,  $T$  is a temperature, and  $i$  is a bias current).

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12. The method for monitoring and controlling wavelengths according to Claim 10, wherein

the step of calculating wavelength information selects a smaller temperature value  $T_1$  than the measured 25 temperature  $T_{mes}$ , a larger temperature value  $T_2$  than the measured temperature  $T_{mes}$ , a smaller bias current value  $I_1$  than the measured bias current  $I_{mes}$  and a larger bias

current value  $I_2$  than the bias current value  $I_{mes}$  by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts four wavelengths ( $\lambda_{11} = \lambda(I_1, T_1)$ ,  $\lambda_{21} = \lambda(I_2, T_1)$ ,  $\lambda_{12} = \lambda(I_1, T_2)$ ), and  $\lambda_{22} = \lambda(I_2, T_2)$  corresponding thereto; and calculates the wavelength  $\lambda_{mes1} = \lambda(I_{mes}, T_1)$  at the measured bias current  $I_{mes}$  by linearly interpolating the bias current dependency of the wavelengths at temperature  $T_1$  using  $\lambda_{11}$  and  $\lambda_{21}$ ; calculates the wavelength  $\lambda_{mes2} = \lambda(I_{mes}, T_2)$  at the measured bias current  $I_{mes}$  by linearly interpolating the bias current dependency of the wavelength at temperature  $T_2$  using  $\lambda_{12}$  and  $\lambda_{22}$ ; and calculates the wavelength  $\lambda_{mes} = \lambda(I_{mes}, T_{mes})$  at the measured bias current  $I_{mes}$  and temperature  $T_{mes}$  by linearly interpolating the temperature dependency of the wavelength at the measured bias current  $I_{mes}$  using the calculated  $\lambda_{mes1}$  and  $\lambda_{mes2}$ .

13. The method for monitoring and controlling wavelengths according to Claim 10, wherein  
the step of calculating wavelength information selects a smaller temperature  $T_1$  than the measured temperature  $T_{mes}$ , a larger temperature  $T_2$  than the measured temperature  $T_{mes}$ , a smaller bias current  $I_1$  than the measured bias current  $I_{mes}$ , a larger bias current  $I_2$  than the measured bias current  $I_{mes}$ , and a bias current  $I_3$  differing from

the bias currents I1 and I2 by using the temperature and bias current measured by the measurement portion and the relationships between the laser diode temperature, bias current and wavelengths stored in the storage portion;  
5 extracts six wavelengths ( $\lambda_{11} = \lambda(I1, T1)$ ,  $\lambda_{21} = \lambda(I2, T1)$ ,  $\lambda_{12} = \lambda(I1, T2)$ ,  $\lambda_{22} = \lambda(I2, T2)$ ,  $\lambda_{31} = \lambda(I3, T1)$ ), and  $\lambda_{32} = \lambda(I3, T2)$  corresponding thereto; approximates the bias current dependency of the wavelength at the temperature T1 by a quadratic function using  $\lambda_{11}$ ,  $\lambda_{21}$  and  $\lambda_{31}$ ;  
10 approximates the bias current dependency of the wavelength at the temperature T2 by a quadratic function using  $\lambda_{12}$ ,  $\lambda_{22}$  and  $\lambda_{32}$ ; and calculates the wavelength  $\lambda_{mes} = \lambda(I_{mes}, T_{mes})$  at the measured bias current  $I_{mes}$  and temperature  $T_{mes}$ .

15

14. The method for monitoring and controlling wavelengths according to Claim 10, wherein

the step of calculating wavelength information extracts a wavelength by causing the measured temperature and bias current to correspond to any one of the temperatures stored in matrices indicating the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion.

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15. The method for monitoring and controlling wavelengths according to Claim 9, wherein

the step of calculating wavelength information obtains  $\lambda_c$ ,  $i_c$ ,  $a$ , and  $b$  in Equation (1) or  $\lambda_c$  and  $a$  in Equation (2) by using the temperature and bias current or only the temperature measured by the measuring portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion, and calculates wavelength information; and

the step of controlling temperature calculates a  
temperature, which gives a prescribed wavelength by using  
the calculated wavelength information and Equations (1)  
or (2), and feeds it back to the temperature adjusting portion  
so as to secure said temperature;

$$\lambda = \lambda_c + aT + b(i - i_c) \quad \dots \dots \text{Equation (1)}$$

$$15 \quad \lambda = \lambda_c + aT \quad \dots \dots \text{Equation (2)}$$

(where  $\lambda_c$  is a wavelength at temperature 0°C and threshold current value  $i_c$ , a and b are coefficients, T is a temperature, and i is a bias current).

20           16. The method for monitoring and controlling  
wavelengths according to Claim 9, wherein

the step of calculating wavelength information selects a smaller temperature value  $T_1$  than the measured temperature  $T_{mes}$ , a larger temperature value  $T_2$  than the measured temperature  $T_{mes}$ , a smaller bias current value  $I_1$  than the measured bias current  $I_{mes}$  and a larger bias current value  $I_2$  than the bias current value  $I_{mes}$  by using

the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature and bias current and wavelengths stored in the storage portion; extracts four wavelengths ( $\lambda_{11} = \lambda(I_1, T_1)$ ,  
5  $\lambda_{21} = \lambda(I_2, T_1)$ ,  $\lambda_{12} = \lambda(I_1, T_2)$ , and  $\lambda_{22} = \lambda(I_2, T_2)$  corresponding thereto; and calculates the wavelength  $\lambda_{mes1} = \lambda(I_{mes}, T_1)$  at the measured bias current  $I_{mes}$  by linearly interpolating the bias current dependency of the wavelengths at temperature  $T_1$  using  $\lambda_{11}$  and  $\lambda_{21}$ ; calculates  
10 the wavelength  $\lambda_{mes2} = (I_{mes}, T_2)$  at the measured bias current  $I_{mes}$  by linearly interpolating the bias current dependency of the wavelength at temperature  $T_2$  using  $\lambda_{12}$  and  $\lambda_{22}$ ; and calculates the wavelength  $\lambda_{mes} = (I_{mes}, T_{mes})$  at the measured bias current  $I_{mes}$  and temperature  $T_{mes}$  by linearly  
15 interpolating the temperature dependency of the wavelength at the measured bias current  $I_{mes}$  using the calculated wavelength  $\lambda_{mes1}$  and  $\lambda_{mes2}$ ; and

the step for controlling temperature calculates a temperature, which gives a prescribed wavelength at the measured bias current  $I_{mes}$ , on the basis of the temperature dependency of the wavelength, and feeds it back to the temperature adjusting portion so as to secure the calculated temperature.

25           17. The method for monitoring and controlling wavelengths according to Claim 9, wherein  
the step of calculating wavelength information

selects a smaller temperature T1 than the measured temperature Tmes, a larger temperature T2 than the measured temperature Tmes, a smaller bias current I1 than the measured bias current Imes, a larger bias current I2 than the measured bias current Imes, and a bias current I3 differing from the bias currents I1 and I2 by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts six wavelengths ( $\lambda_{11} = \lambda(I1, T1)$ ,  $\lambda_{21} = \lambda(I2, T1)$ ,  $\lambda_{12} = \lambda(I1, T2)$ ,  $\lambda_{22} = \lambda(I2, T2)$ ,  $\lambda_{31} = \lambda(I3, T1)$ , and  $\lambda_{32} = \lambda(I3, T2)$  corresponding thereto; approximates the bias current dependency of the wavelength at the temperature T1 by a quadratic function using  $\lambda_{11}$ ,  $\lambda_{21}$  and  $\lambda_{31}$ ; approximates the bias current dependency of the wavelength at the temperature T2 by a quadratic function using  $\lambda_{12}$ ,  $\lambda_{22}$  and  $\lambda_{32}$ ; and calculates the wavelength  $\lambda_{mes} = \lambda(Imes, Tmes)$  at the measured bias current Imes and temperature Tmes; and

the step for controlling temperature calculates a temperature, which gives a prescribed wavelength at the measured bias current Imes, on the basis of the temperature dependency of the wavelength, and feeds it back to the temperature adjusting portion so as to secure the calculated temperature.

#### 18. The method for monitoring and controlling

wavelengths according to Claim 9, wherein

the step of calculating wavelength information extracts a wavelength information by causing the measured temperature and bias current to correspond to any one of the temperatures stored in matrices indicating the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion; and

the step of controlling temperature extracts a temperature from the matrices, which gives a prescribed wavelength at the corresponding bias current, and feeds it back to the temperature adjusting portion so as to secure the extracted temperature.

19. A method for monitoring and controlling wavelengths according to any one of Claims 9 through 18, further comprising a laser diode drive current controlling circuit which controls the drive current of the laser diode, wherein, the method further comprising, before the step of calculating wavelength information, steps of:

comparing threshold values of an optical output alarm or warning, in which the minimum value and maximum value of optical output are predetermined, with the optical output measured by the measurement portion; and

25 on the basis of a comparison made by the optical output comparing step, feeding the result back to the laser diode drive current controlling circuit when the result is outside

the range of the threshold values, raising the bias current by the laser diode drive current controlling circuit if the result is smaller than or equal to the minimum value of the threshold values, and lowering the bias current by  
5 the laser diode drive current controlling circuit if the result is larger than or equal to the maximum value of the threshold values.